

WHAT IS CLAIMED IS:

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1 1. A process of manufacture of electrostatic speakers comprising interposing and
2 affixing a chargeable membrane between a first side and an opposing side, wherein
3 i) said first side is selected from the group consisting of:
4 (1) a PCB comprising at least one stator, electrical circuitry to the at least one
5 stator, and a raised structure integral with the PCB that surrounds a central
6 speaker area such that said raised structure contacts the membrane; and,
7 (2) a PCB comprising at least one stator and electrical circuitry to the at least
8 one stator, and a separate raised structure that surrounds a central speaker
9 area such that said separate raised structure contacts the membrane; and,
10 ii) said opposing side is selected from the group consisting of:
11 (1) a PCB comprising at least one stator, electrical circuitry to the at least one
12 stator, and a raised structure integral with the PCB that surrounds a central
13 speaker area such that said raised structure contacts the membrane;
14 (2) a PCB comprising at least one stator and electrical circuitry to the at least
15 one stator, and a separate raised spacing structure that surrounds a central
16 speaker area such that said spacing structure contacts the membrane;
17 (3) a fastening structure disposed peripherally to a central speaker area,
18 whereby said fastening structure contacts the membrane over or lateral to
19 said raised structures of said first side;
20 (4) an opposing structure that spans the central speaker area, comprising a
21 raised structure positioned to meet the first side's raised structure,
22 whereby said opposing side raised structure contacts the membrane, and
23 optionally comprising at least one stator and electrical circuitry to the at
24 least one stator; and,
25 (5) an opposing structure that spans the central speaker area, optionally
26 comprising at least one stator and electrical circuitry to the at least one
27 stator, and a separate raised structure positioned to meet the first side's

raised structure, whereby said opposing side raised structure contacts the membrane; and

iii) a means for conducting a charge to said membrane is provided.

2. An electrostatic speaker made by the process of claim 1.

3. A process of manufacture of electrostatic speakers comprising the steps of:

- a affixing a first side of a chargeable membrane on or over a first printed circuit board, said printed circuit board comprising at least one stator;
- b affixing either (i) a second printed circuit board or (ii) an opposing membrane holding means, on or over a second side of said membrane, to said first printed circuit board;
- c providing an electric circuitry means for transmitting an electric biasing current to the membrane; and
- d providing an electric circuitry means for transmitting an electric signal to said at least one stator.

4. An electrostatic speaker made by the process of claim 3.

5. A process of manufacture of electrostatic speakers comprising the steps of:

- a. preparing a printed circuit board comprising at least one stator, at least one electrical circuit, and a surrounding membrane holding means; and
- b. affixing a chargeable membrane onto said surrounding membrane holding means.

6. An electrostatic speaker made by the process of claim 5.

7. A process of manufacture of electrostatic speakers comprising the steps of:

- a Preparing a first printed circuit board comprising at least one stator, at least one electrical circuit, and a surrounding membrane holding means;

- b Preparing an opposing membrane holding means, said opposing membrane holding means comprising a surrounding membrane holding means, and optionally comprising at least one electrical circuit; and
- c Affixing a membrane between said printed circuit board and said opposing membrane holding means;
- whereby said one electrical circuit situated on the printed circuit board connects to said at least one stator, and at least one electrical circuit situated either on said printed circuit board or on said opposing membrane holding means connects to the membrane.

8. An electrostatic speaker made by the process of claim 7.

9. The process of manufacture of electrostatic speakers according to claim 7 wherein, in affixing the membrane between said printed circuit board and said opposing membrane holding means, a central speaker area is situated internal to the area defined by the surrounding membrane holding means, said central speaker area having a space sufficient to permit said membrane to vibrate without contacting any part of, or transferring a charge from the membrane to, the printed circuit board or the opposing membrane holding means, said sufficient space provided either by: (i) preparing the surrounding membrane holding means on one or both sides of the membrane with sufficient height; (ii) preparing the printed circuit board and preparing the opposing membrane holding means, such that each part's central speaker area has sufficient space; (iii) providing an additional means for spacing between the membrane and the printed circuit board and the opposing membrane holding means; or, providing the sufficient space by a combination selected from (i), (ii) and (iii).

10. The process of manufacture of electrostatic speakers according to claim 9 wherein said printed circuit board, said opposing membrane holding means, or both, are provided with at least one aperture to facilitate the passage of acoustical signals beyond said electrostatic speaker.

1 11. The process of manufacture of electrostatic speakers according to claim 10 wherein
2 the surrounding membrane holding means of the printed circuit board is prepared
3 with at least one continuous ridge surrounding the central speaker area, and the
4 opposing membrane holding means is prepared with at least two parallel continuous
5 ridges, wherein, during affixing the membrane, the membrane is positioned and
6 tensioned by the parallel ridges of the surrounding membrane holding means and the
7 opposing membrane holding means press the membrane into valleys between the
8 ridges of the opposing structure as the printed circuit board and the opposing
9 membrane holding means are affixed together.

1 12. The process of manufacture of electrostatic speakers according to claim 11 wherein
2 the opposing membrane structure comprises a printed circuit board.

1 13. The process of manufacture of electrostatic speakers according to claim 12 wherein
2 said first printed circuit board, said printed circuit board that comprises said opposing
3 membrane holding means, or both of said printed circuit boards, additionally
4 comprise a metallic shielding means covering a sufficient portion of the exterior layer
5 of said one or both printed circuit boards to reduce transmission of electromagnetic
6 radiation beyond said electrostatic speaker.

1 14. The process of manufacture of electrostatic speakers according to claim 12 wherein
2 the opposing membrane structure comprises a printed circuit board, said printed
3 circuit board additionally comprising at least one stator and electrical circuitry
4 connecting to said at least one stator.

1 15. The process of manufacture of electrostatic speakers according to claim 12 wherein
2 the first printed circuit board, the opposing membrane holding means, or both, are
3 prepared with electrical connections for the connection of at least one external source
4 of electrical impulses to said electrical circuitry.

- 1 16. The method of manufacture of electrostatic speakers according to claim 13
2 comprising the additional steps of: attaching a blind cavity distal to one PCB to form
3 a sound box.
- 1 17. An electrostatic speaker made by the process of claim 15.
- 1 18. An electrostatic speaker made by the process of claim 16.
- 1 19. The process of manufacture of electrostatic speakers according to claim 1 comprising
2 the additional step of separating, as by cutting, heating, or pressing, the excess
3 membrane situated distal to said raised or separate structures contacting said
4 membrane.
- 1 20. The process of manufacture of electrostatic speakers according to claim 19
2 comprising the additional step of heating an affixed ESL for a sufficient time to make
3 the membrane taut.
- 1 21. The process of manufacture of electrostatic speakers according to claim 20 wherein
2 said first side and said opposing side, or both, are provided with at least one aperture
3 to facilitate the passage of acoustical signals beyond said electrostatic speaker.
- 1 22. The process of manufacture of electrostatic speakers according to claim 21 wherein
2 said raised or separate structures contacting said membrane on either side are
3 prepared from a group consisting of:
4 a. a roughened contacting surface having a high friction coefficient;
5 b. a contacting surface designed to receive adhesive effectively over a relatively
6 broad area; and
7 c. opposing sets of parallel ridges, one structure having at least one ridge, and the
8 other structure having at least two ridges, where an opposing ridge interposes
9 between two ridges on the other structure continuously around the central
10 speaker area.

1 23. The process of manufacture of electrostatic speakers according to claim 22 wherein at
2 least one plate, peripheral to and surrounding the raised structures contacting said
3 membrane, supports the compressive forces from fastening means that affix the
4 membrane between said first side and said opposing side.

1 24. The method of manufacture of electrostatic speakers according to claim 22 wherein
2 the method of affixing said membrane between said first side and said opposing side
3 employs evenly spaced screws, nuts and bolts, clips with holes for clips on the
4 opposing side, where the clips attach under tension to the distal end of such holes, or
5 similar mechanical attachments between said first and second printed circuit boards.

1 25. The method of manufacture of electrostatic speakers according to claim 22 wherein
2 one side of the ESL has a single aperture upon which a tube is fitted to transfer
3 acoustical signals directly to a listening subject.

1 26. An electrostatic speaker made by the process of claim 22.

1 27. A process of manufacture of electrostatic speakers comprising the steps of:

- 2 a. Applying adhesive to a surrounding membrane holding means in each speaker
3 area of a first PCB panel, said first PCB panel comprising at least one speaker
4 area, each said speaker area comprising at least one stator centrally positioned in
5 a central speaker area, electrical circuitry to said at least one stator, and said
6 surrounding membrane holding means;
- 7 b. Stretching a membrane over said first PCB panel;
- 8 c. Pressing said membrane into contact with said first PCB panel, whereby
9 selectively pressure, heat, radiation, or a combination of these, adhere said
10 membrane to said surrounding membrane holding means of each speaker area;
- 11 d. Cutting excess membrane material situated beyond edges of the surrounding
12 membrane holding means of each speaker area;
- 13 e. Separating excess membrane material from the first PCB panel additionally
14 comprising attached membrane material;

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- 15 f. Superposing a second PCB panel, said second PCB panel comprising at least one
16 speaker area, each said speaker area comprising a surrounding membrane holding
17 means, wherein each speaker area of the second PCB panel conforms
18 geometrically to match an opposing speaker area in said first PCB panel;
19 g. Affixing each set of opposing speaker areas in said first PCB panel and said
20 second PCB panel.

1 28. The method of manufacturing electrostatic speakers according to claim 27, wherein a
2 plurality of speaker areas on the first and second PCB panels are connected by
3 support structures, said support structures providing a means of alignment during the
4 assembly steps.

1 29. The method of manufacturing electrostatic speakers according to claim 27, wherein
2 after affixing together said first PCB panel and said second PCB panel, each speaker
3 area is separated from said support structures.

1 30. An electrostatic speaker made by the process of claim 29.

1 31. A method of producing sound in a situation where use of standard
2 electromagnetically based sound transducers would be unacceptable, which
3 comprises producing sound by means of an electrostatic speaker integral to a PCB.

1 32. The method according to claim 31 wherein said situation involves Magnetic
2 Resonance Imaging (MRI) of a patient.

1 33. An electrostatic speaker comprising a chargeable membrane interposed between and
2 affixed to a first side and an opposing side, wherein
3 i) said first side is selected from the group consisting of:
4 (1) a PCB comprising at least one stator, electrical circuitry to the at least one
5 stator, and a raised structure integral with the PCB that surrounds a central
6 speaker area such that said raised structure contacts the membrane; and,

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- 7 (2) a PCB comprising at least one stator and electrical circuitry to the at least
8 one stator, and a separate raised structure that surrounds a central speaker
9 area such that said separate raised structure contacts the membrane; and,
10 ii) said opposing side is selected from the group consisting of:
11 (1) a PCB comprising at least one stator, electrical circuitry to the at least one
12 stator, and a raised structure integral with the PCB that surrounds a central
13 speaker area such that said raised structure contacts the membrane;
14 (2) a PCB comprising at least one stator and electrical circuitry to the at least
15 one stator, and a separate raised spacing structure that surrounds a central
16 speaker area such that said spacing structure contacts the membrane;
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18 whereby said fastening structure contacts the membrane over or lateral to
19 said raised structures of said first side;
20 (4) an opposing structure that spans the central speaker area, comprising a
21 raised structure positioned to meet the first side's raised structure,
22 whereby said opposing side raised structure contacts the membrane, and
23 optionally comprising at least one stator and electrical circuitry to the at
24 least one stator; and,
25 (5) an opposing structure that spans the central speaker area, optionally
26 comprising at least one stator and electrical circuitry to the at least one
27 stator, and a separate raised structure positioned to meet the first side's
28 raised structure, whereby said opposing side raised structure contacts the
29 membrane; and
30 iii) a means for conducting a charge to said membrane.

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